Natural Sciences 102 -- Spring 2004
Exam #2, May 20, 2004

Name (PLEASE print legibly):

General instructions:

- For essay and descriptive questions, please be complete, but concise. Answers should be limited to the space provided under the question.
- Please manage your time. First answer the questions you know best.
- **Each problem is worth 10 points.**
- Some formulae you may find useful:

1 (10)	2 (20)	3 (10)	4 (10)	5 (10)	6 (10)	7 (10)	8(10)	Total (80)

apparent magnitudes of objects 1 & 2 (I = intensity): $m_1 - m_2 = -2.5 \log\left(\frac{I_1}{I_2}\right)$

apparent magnitude of the sun: -26.8

1 pc = 200,000 AU

Hubble's law: $v = H_0 d$

speed of light: 300,000 km s^{-1}

speed of sound: 700 miles per hour

speed of smell: 200 inches per minute

shift in wavelength due to motion (c = velocity of the wave): $\frac{\lambda}{\lambda_0} = 1 \pm \frac{v}{c}$

Inverse square law: intensity $= \left(\frac{\text{luminosity}}{4\pi R^2}\right)$

Luminosity of the sun: 10^{26} Watts

Luminosity of President Bush: 10^{-4} Watts

$\left(\frac{\text{distance}}{\text{pc}}\right) = \left(\frac{\text{seconds}}{\text{parallax}}\right)$

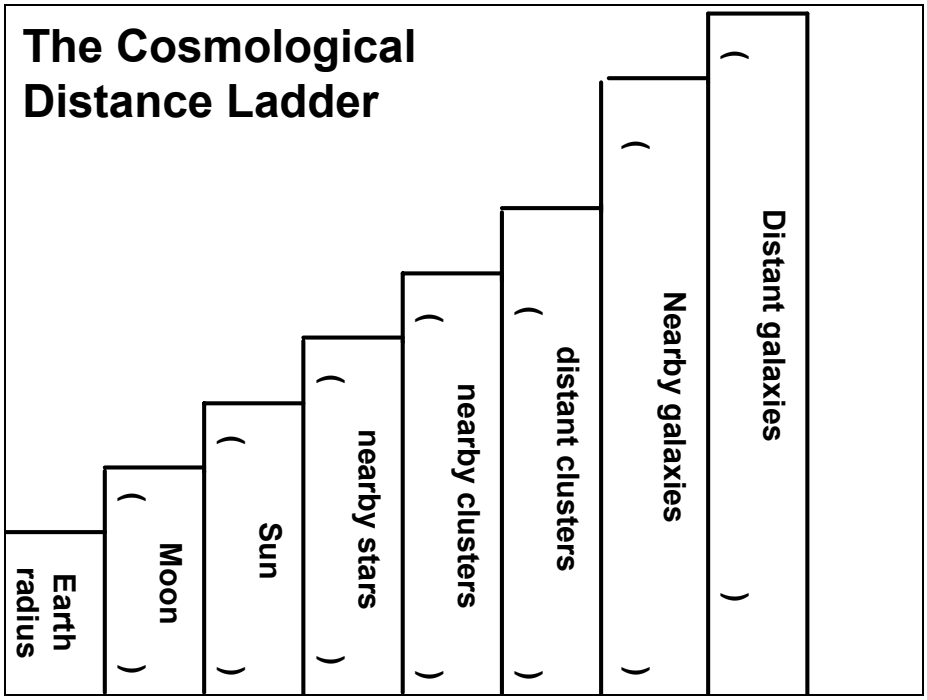
1 Mpc = 3×10^{19} km

I. The Cosmological Distance Scale:

Three things you can measure about stars are that 1) they appear to have different brightness, 2) they appear to have different colors, and 3) they may changes in brightness. Give one example of how each of these properties is used in the construction of the distance ladder. Please describe each example.

II. The Cosmological Distance Scale:

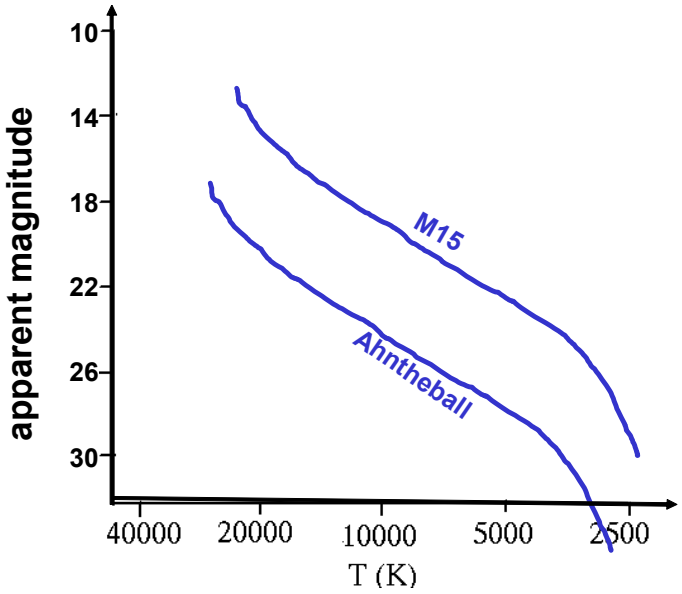
a) For each step in the distance ladder, fill in (in the parentheses) the method used to determine the distance. Choose from Cepheid, Faith-Based Determination, Geometry, H-R Diagram, Hubris, Hubble's Law, Parallax, RR-Lyrae, or Radio Dating.



III. The H-R Diagram as a distance indicator:

a) Describe in words (use equations if you wish) how the H-R diagram can be used as a distance indicator.

b) The distance to the cluster M15 is known to be 1000 pc. Another cluster is discovered by Sein Ahn, named the Ahntheball cluster. Use the information from the H-R diagrams below to calculate the distance to Ahntheball.



IV. Parallax:

a) What is annual stellar parallax? What moves, and what appears to move?
b) Draw a diagram indicating the parallax angle, the distance known by other means and the distance determined by parallax.
c) The annual stellar parallax of the star Chisholm 321 is measured to be 0.02 seconds of arc. What is its distance?

V. Doppler Shift:

a) Define the Doppler shift and explain how it can be used to determine velocity.
b) Justin Johnsen is driving his new pickup truck from Texas to Hyde Park. While passing through a trailer park outside of the small town of Rectalrash, Arkansas, he is pulled over for running a red light. He claims the light looked green to him because of the Doppler effect. The wavelength of red light is 6000 Angstroms and the wavelength of green light is 4500 Angstroms.
    1. In order for a red light to appear green, would Justin have to be traveling toward the light or away from the light?
    2. Estimate Justin's speed for a red light to appear green?

VI. Cosmological Principle:

a) Please state the cosmological principle.
b) What are the implications of the cosmological principles for the center and edge of the universe?
c) Reconcile the observational fact that most galaxies are receding from us with the cosmological principle. Why wouldn't that fact make us special?

VII. Magnitudes:

a) Why is the magnitude scale based on a lograrithmic scale?
b) Which appears brighter, a star of 12^{th} apparent magnitude or a star of 7^{th} apparent magnitude?
c) The star Cheney-V has an apparent magnitude of m = –1. Another star, Kerry-7, is the same distance from us as Cheney-V, but has a luminosity of one hundred times the luminosity of Cheney-V. What is the apparent magnitude of Kerry-7?
d) Using the luminosity of President Bush given on the instruction page, calculate his magnitude if he was as far away as the sun.

VIII. Big Bang:

Please respond to the following "fact or fiction," and explain how you know the answer.